

New Fire Monitoring and Early warning System in Kolkheti National Park

1. Background and context

Overview of Kolkheti National Park

Kolkheti National Park, managed by the Agency of Protected Areas, is a unique ecological reserve along Georgia's Black Sea coast. It comprises a mosaic of ecosystems including Colchic wetlands, peat bogs, lakes (notably Lake Paliastomi), and coastal habitats. The park holds international significance and is recognized as a UNESCO World Natural Heritage Site under the designation 'Colchic Rainforests and Wetlands'.

Ecological Importance in Eurasian Context

Kolkheti National Park contributes to the preservation of biodiversity and climate regulation in the Eastern Black Sea region. Its wetlands act as vital carbon sinks and are critical resting and breeding grounds for migratory birds within the Afro-Eurasian Flyway. The park serves as a buffer against sea-level rise and supports hydrological balance in the region.

2. Problem Statement

Fire and Smoke Threats to Wetland Ecosystems

Despite being a wetland, Kolkheti faces increasing threats from:

- Dry seasons and peat degradation due to climate change,
- Illegal burning and agricultural activities nearby,
- Smoke hazards affecting biodiversity and air quality.

Fire events, though less frequent than in forested areas, can cause irreversible damage to peat layers and release stored carbon.

Why Prevention is Critically Important

- **Time is Critical:**
Wildfires spread rapidly. Delayed responses result in irreversible damage. Early warning systems safeguard ecosystem resilience.
- **Energy and Cost Efficiency:**
Prevention is far less costly than managing the aftermath of wildfires (which requires technical, human, and restoration resources).
- **Compliance with International Environmental Obligations:**
As part of the EU Neighborhood Policy and the Bern Convention, Georgia must take effective action, as supported by project RFP 3100005138.

- **Technological Sovereignty and Resilience:**
A national monitoring system ensures independent and timely response, empowering local agencies in disaster risk management.

3. Opportunity

Through the **UNEP Project RFP 3100005138** several technical solutions for detection and early warning of forest fires were benchmarked and following consultations with main stake holders, a system was developed and implemented as a pilot project.

The system is already operational in Abastumani, with two surveillance points established:

a) Zekari Pass:

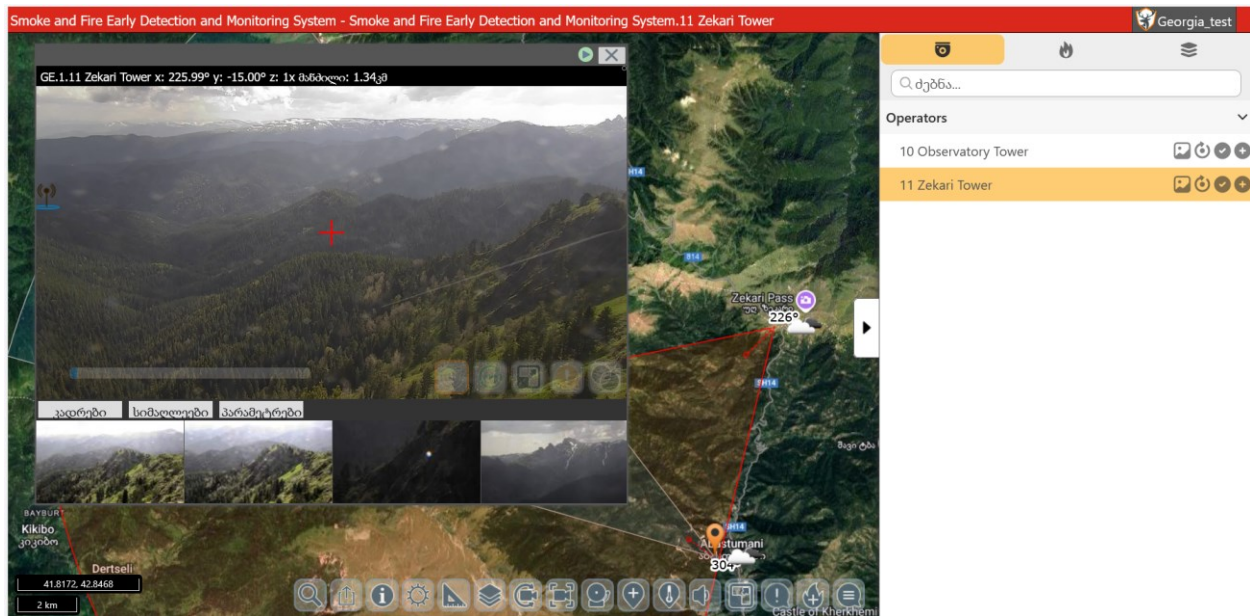
- A 6-meter communication tower constructed
- Lightning rod installed
- Secure room built
- Solar power supply system installed
- Stable internet connection provided
- Forest monitoring video camera installed
- Security camera installed for perimeter surveillance

b) Abastumani Observatory:

- A forest monitoring video camera installed at a height of 22 meters on an existing tower

Both cameras are integrated into the central system Smoke and Fire Detection System (see Figure 1) and provide 24/7 forest area monitoring:

- Zekari camera: covers 7,700 hectares
- Observatory camera: covers 4,100 hectares



Pic. 1 – Position of existing cameras

The technical solution is suitable for the natural conditions as well as for the institutional capacity of the natural protected area administration, so it can be up scaled in order to cover the whole area of the National Park.

A major benefit is the fact that the software component of the system that was developed within the UNEP Project RFP 3100005138 can be used for the scale up solution without any additional costs. All forest monitoring video cameras installed in the Borjomi area will be integrated into the existing Smoke and Fire Monitoring System.

4. The Proposed Technical Solution

The early smoke and fire detection is carried out through selected video cameras that monitor the forest area with a 360-degree field of view and transmit real-time video footage to a centralized system. This central system uses artificial intelligence tools to analyze the video stream and automatically detect smoke and fire.

The core of the system is a data processing center – a complex of servers and software. The servers process, store, and analyze the data received from the cameras, calculate and map relevant information, manage routing and security, and respond to user requests.

Video cameras can be installed on towers or any suitable structures. The placement of cameras is determined using Geographic Information Systems (GIS), which identify optimal coverage zones based on visibility of high-risk areas. Key factors considered include tower coordinates and height, forest flammability, terrain, atmospheric transparency, and minimization of high-maintenance

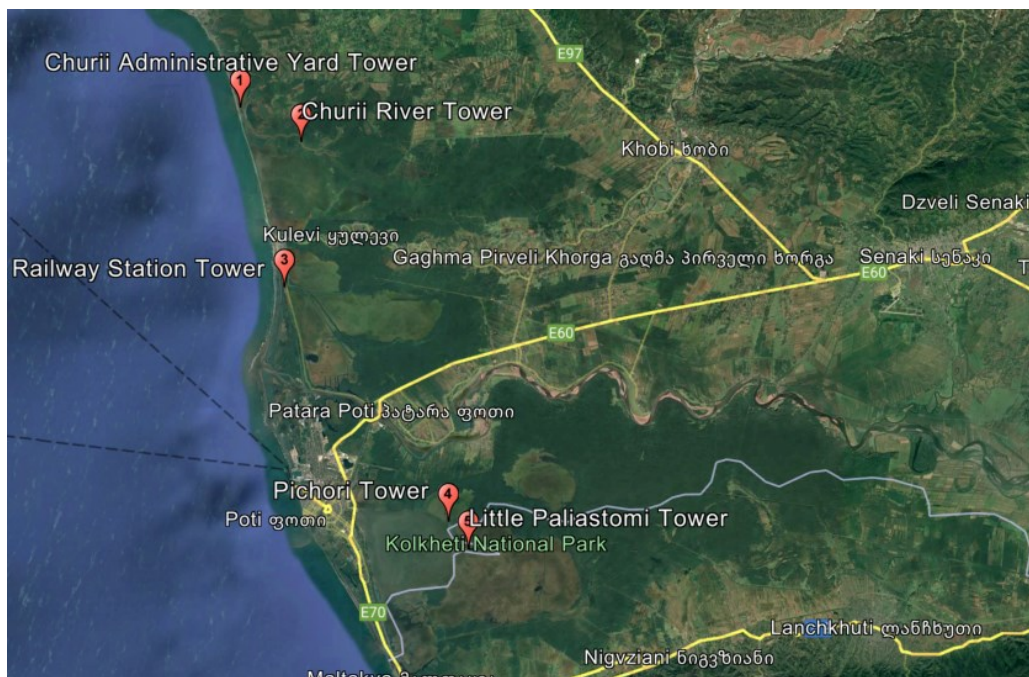
locations. All cameras are integrated into a unified system. Uninterrupted power supply and stable internet connectivity are essential for their operation.

To ensure full functionality of the system in protected areas, the following infrastructure is required:

- Mast for video camera installation
- Lightning protection system
- Solar power system
- Secure cabinet/room for active equipment
- Forest monitoring video camera
- Security video cameras for the tower's perimeter
- Communication equipment for internet connectivity
- The fencing of the constructed infrastructure area.

Selected Locations

There are already five watchtowers (each 7 meters high) installed within Kolkheti National Park and its surrounding area. Their coordinates are shown on the map below and listed in Table No. 1.



Pic.2 - Map of existing tower locations

Table N1, table of coordinates and height of existing watchtowers

N	Name	Lattitude DMS	Longitude DMS	Heigth (m)
Tower 1	Churii Administrative Yard Tower	42°20'13.98"N	41°36'42.42"E	7.0
Tower 2	Churii River Tower	42°19'14.55"N	41°39'9.15"E	7.0
Tower 3	Railway Station Tower	42°14'58.37"N	41°38'35.97"E	7.0
Tower 4	Pichori Tower	42° 8'11.72"N	41°45'14.56"E	7.0
Tower 5	Little Paliastomi Tower	42° 7'24.06"N	41°46'2.84"E	7.0

To ensure monitoring of the designated area, project planning has been completed, and three locations have been identified. At these locations, video cameras will be installed on existing towers, with uninterrupted power supply and internet connectivity provided. The three new video cameras will be integrated into the existing Smoke and Fire Detection System.

Table2. table of coordinates and height of selected tower

N	Tower Name	Lattitude DMS	Longitude DMS	Heigth (m)
Tower 1	Churii Administrative Yard Tower	42°20'13.98"N	41°36'42.42"E	7.0
Tower 3	Railway Station Tower	42°14'58.37"N	41°38'35.97"E	7.0
Tower 5	Little Paliastomi Tower	42° 7'24.06"N	41°46'2.84"E	7.0

Each of the designated towers will be equipped with the following:

- ✓ A forest monitoring video camera with a mounting bracket (total weight: 7 kg)
- ✓ A communication antenna from the internet provider (1 meter in diameter)
- ✓ A security camera for monitoring the surrounding area (local surveillance), total weight 2 kg

Solar Panel Power System

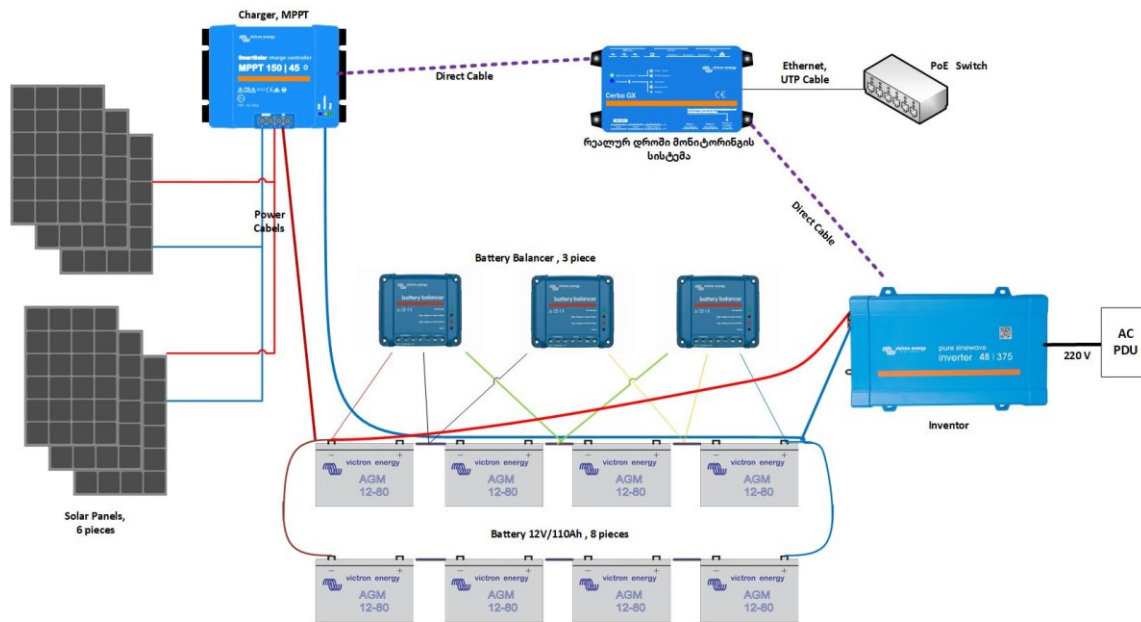
Requirements for the Power System:

- ✓ Required power capacity per tower:

Table 3 – Power capacity per tower

Tower Name	Internet Provider Consumption per Site, W	Video cameras and network equipments W	Sum, W
Churii Administrative Yard Tower	75	130	205
Railway Station Tower	75	130	205
Little Paliastomi Tower	75	130	205

- ✓ Required voltage: 20–60 VDC or 220 VAC
- ✓ The number of panels must ensure system charging even during short daylight hours
- ✓ The system must provide uninterrupted power supply for up to 7 days during poor weather conditions (e.g., cloud cover, limited sunlight)
- ✓ Battery protection and charge balancing must be ensured
- ✓ System monitoring must be available via the internet, including:
 - Input charging power from panels
 - Load consumption
 - Discharge levels
 - Remaining battery capacity (with the ability to forecast how long the system will remain operational during poor weather when full charging is not possible)
- ✓ Panels must be installed in the vicinity of the tower
- ✓ A complete power distribution setup must be built: including a PDU, inverter, and internal power network (AC or DC)
- ✓ The electrical power system must be fully tested and ensure reliable operation of the entire system
- ✓ All system components must have a minimum 1-year warranty
- ✓ Upon completion of installation, technical drawings and documentation must be provided



Pic.3 – Solar panels system diagram

Secure room/equipment cabinet

A secured room or cabinet will be installed near the tower with the following specifications:

Minimum dimensions: 150 x 150 x 200 cm

The following equipment will be housed inside:

- Batteries
- Solar panel equipment – panel and battery management system
- Electrical distribution board with circuit breakers/switches
- Networking equipment – internet/VPN router, switch, Silknet/Magti router
- Power supply unit for the forest monitoring video camera – AXIS camera PoE device
- Power supply for the security cameras
- Indoor security camera for monitoring the interior space

Interior shelving will be installed to accommodate the batteries and equipment.



Pic.4 – Secure room/equipment cabinet

Video Cameras

Video Cameras for the Fire and Smoke Detection System will be installed on the selected Towers:

AXIS Q6075-E PTZ Network Camera , <https://www.axis.com/products/axis-q6075-e#technical-specifications>

AXIS Q6075-E PTZ Network Camera

Outdoor-ready PTZ with HDTV 1080p and 40x optical zoom





- ✓ HDTV 1080p with 40x optical zoom
- ✓ Axis Lightfinder 2.0
- ✓ Autotracking 2 and orientation aid
- ✓ Built-in analytics
- ✓ TPM, FIPS 140-2 level 2 certified



Wall Mount - AXIS T91G61 Wall Mount, <https://www.axis.com/products/axis-t91g61-wall-mount>

AXIS T91G61 Wall Mount

Quick connection and room for more

-  Room for connectivity devices, midspans and service loop
-  Protection against impacts, water, dust and corrosion
-  Pre-mounted Ethernet cable with IP66 RJ45 connector
-  Re-use existing holes



All three video cameras will be integrated into the existing Fire and Smoke Detection System, providing access to designated Kolkheti Park personnel. Staff members will receive training on system operation and will be provided with user instructions.

Security Cameras for the Tower Area

To ensure security in the vicinity of the tower, an outdoor security camera will be installed on the tower. For monitoring the interior of a secured room or cabinet, an indoor-use camera will be installed. All security cameras will be connected to a video surveillance system, which will be located at the Borjomi Protected Area administration building. Authorized staff members will have appropriate access to this system.

Communication Equipment and Internet Connection

Each selected location/tower must be provided with an uninterrupted internet connection, with a minimum bandwidth of 15 Mbps. A local area network (LAN) must be established, and the following devices must be connected to the internal network:

Forest monitoring video camera;

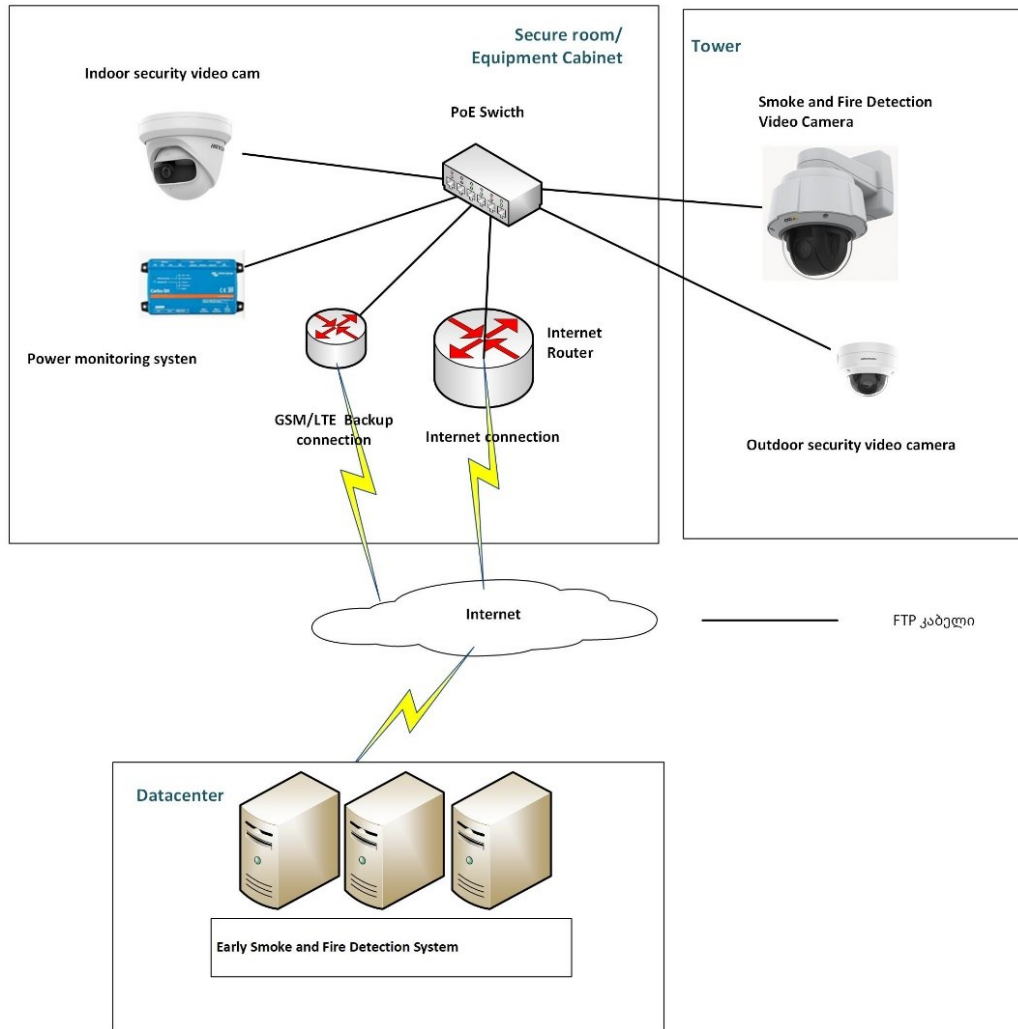
Local/perimeter security video cameras;

Solar panel management and monitoring system.

Through the internet connection, the forest monitoring camera must be integrated into the existing Fire and Smoke Detection System (Central Server).

See Pic.5 for a typical diagram of the internet-computer network of a tower located in the wild area.

Network diagram



5. Cost Estimate of Infrastructure

Solar Panels System and Secure Room/Equipment Cabinet

N	Description	Qty	Unit price, USD	Sum, USD
1	Solar panels LONGI Solar 610 Wp	6	132,62	795,70
2	MUST PV18-5248 pro (5.2KW), Battery Mgm Syst, Newmax, 8 battery sets	1	2 757,40	2 757,40
3	AC DC cables, cable channels and other equipment	1	281,67	281,67
4	Secure room, equipment cabinet	1	2 796,61	2 796,61
5	Remote monitoring tools	1	1 200,00	1 200,00
6	Environment monitoring equipment	1	1 100,00	1 100,00

7	Installation, configuration cost	1	7 584,75	7 584,75
Sum, without VAR				16 516,13
VAT			18%	2 972,90
One Tower, Solar Pannel System and SecureRoom/Equipment Cabinet				19 489,03

Total, 3 Towers, Solar Panels System and Secure room/equipment cabinet		3		58 467,09
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Smoke and Fire Detection Video Cameras and Central Management System

No	Description	Qty	Unit price (USD)	Sum (USD)
1	AXIS Q6075-E PTZ Network Camera Video Camera	3	15.859,20	47.577,60
2	Wall mount- AXIS T91G61 Wall Mount			
3	Video camera installation, configuration, integration into the Central Management System, linking to the map, annual service			
Sum, without VAT				47.577,60
VAT			18%	8.563,97
Total, 3 Towers , Video Cameras for Fire and Smore Detection System				56.141,57

**Please note that from July 1, 2026, the annual fee for one camera will be the equivalent of 6,026 USD in GEL, at the National Bank exchange rate on the day of payment.

Security Video Cameras

N	Description	Qty	Unit Price (USD)	Sum (USD)
<i>OUTDoor Video Camera</i>				
1	Video Camera IP Hikvision, DS-2CD2345G0P-I, 1.68mm, 4mp, Turret, IR10m, microSD	3	450,00	1 350,00
	MICRO SD CARD HS-TF-P1/128G	3	157,00	471,00
	Wall Mount DS-1473ZJ-155	3	39,00	117,00
	SUM			1 938,00
<i>INDOOR Video Camera</i>				
2	Video Camera IP Hikvision, DS-2CD2345G0P-I, 1.68mm, 4mp, Turret, IR10m, microSD	3	240,00	720,00
	MICRO SD CARD HS-TF-P1/128G	3	157,00	471,00
	Wall Mount	3	17,00	51,00
	SUM			1 242,00

3	NVR, Hikvision, DS-7732NI-M4, 32ch	1	900,00	900,00
4	Video Cameras Installation , Configuration	3	1 500,00	6 200,00
SUM				10 280,00
VAT			18%	1 850,40
Total, 3 Tower, Secure Video Cameras				12 130,40

Tower Network Equipment and Internet cost

N	Description	Qtty	Unit price, without VAT (USD)	Sum, without Vat (USD)
1	Router -Industrial router, LTE Cat 6 Router	2	620,00	1 240,00
2	Switch - industrial switch 5 10/100/1000 ports PoE+ Switch,	1	270,00	270,00
3	LAN, WAN and Internet connection installation and configuration	1	4 181,82	4 181,82
4	Internet service fee, up to 31.12.2025	1	1 849,00	1 849,00
SUM, without VAT				7 540,82
VAT				1 357,35
One tower network cost, with VAT				8 898,16
Total, 3 Towers network cost		3		26 694,49

Project Total Cost

N	Description	Sum (USD)
1	Solar Panels and Secure Room/Equipment Cabinet	58 467,09
2	Fire and Smore Detection System, Video Cameras	56 141,57
3	Security Video Cameras	12 130,40
4	Tower's network and Internet connection	26 694,49
Total, 3 Towers cost		153 433,55

NB. The above estimate covers only the cost of infrastructure. Additional costs with soft components such as training sessions for the future users of the infrastructure and project management costs are not included.

6. Conclusion

The imperative of implementing a fire monitoring and early warning system is determined by the fact that protecting the Kolkheti National Park's conservation is vital for both national biodiversity and regional ecological resilience. By introducing advanced early warning systems, Georgia demonstrates its proactive stance in integrating technology for environmental protection. This approach not only safeguards the Colchic wetlands but also sets a replicable model for wetland fire risk management globally.